Claims

We Claim:

1. A method of preparing a polymer comprising:
   allowing a polymerization mixture to polymerize in at least one closed reaction chamber configured as a linear void space with a linear axis and a cross-section and first and second ends, the linear void space surrounded by a chamber wall having an inner chamber surface and an outer heat exchange surface;
   passing coolant over the outer heat exchange surface;
   opening the ends of the reaction chamber; and
   removing essentially all of the polymer from each reaction chamber with a harvesting plunger traveling along the linear axis of the void space from the first end to the second end.

2. The method of claim 1 where the polymer is poly(alpha-olefin).

3. The method of claim 2 where the poly(alpha-olefin) is suitable for use as a drag reducing agent.

4. The method of claim 1 where the polymerization mixture comprises monomers selected from the group consisting of alpha-olefin monomers having a carbon chain length from 2 to 40.

5. The method of claim 1 where the polymerization mixture includes at least one alpha-olefin monomer, at least one Ziegler-Natta catalyst, and at least one alkyl aluminum co-catalyst.

6. The method of claim 1 where the polymerization temperature is from about 0 to about 150°F (about -18 to about 66°C), and the temperature does not vary by more than about 5°F (about 3°C), during the polymerization.

7. The method of claim 1 where the polymerization temperature is from about 0 to about 150°F (about -18 to about 66°C), and the temperature can vary by up to 80°F (about 44°C), during the polymerization.

8. The method of claim 1 further comprising prior to polymerizing, purging the reaction chamber with a gas or liquid inert to the polymerization.

9. The method of claim 1 further comprising prior to polymerizing, applying a release agent to the inner chamber surface.

10. The method of claim 9 where the release agent is selected from the group consisting of silicones, silicone emulsions, polyethylene glycols, polyethylene waxes, polytetrafluoroethylene dispersions, and sleeves made from polyethylene.

11. The method of claim 9 where the release agent is applied to the inner chamber surface with an application plunger.

12. The method of claim 1 where the harvesting plunger has a cross-section that mates with the uniform cross-section of the linear void space.

13. The method of claim 1 further comprising cleaning each reaction chamber with a cleaning plunger.

14. A method of preparing a polymer comprising:

purging at least one reaction chamber with a gas or liquid inert to the polymerization, the at least one reaction chamber configured as a linear void space with a linear axis and a cross-section and first and second ends, the linear void space surrounded by a chamber wall having an inner chamber surface and an outer heat exchange surface;

passing coolant over the outer heat exchange surface;
applying a release agent to the inner chamber surface;
allowing a polymerization mixture to polymerize in the at least one reaction chamber at a polymerization temperature;
opening the ends of the reaction chamber; and
removing essentially all of the polymer from the at least one reaction chamber with a harvesting plunger traveling along the linear axis of the void space from the first end to the second end.

15. The method of claim 14 where the polymer is poly(alpha-olefin).

16. The method of claim 14 where the polymerization mixture comprises monomers selected from the group consisting of alpha-olefin monomers having a carbon chain length from 2 to 40.

17. The method of claim 14 where the polymerization mixture includes at least one alpha-olefin monomer, at least one Ziegler-Natta catalyst, and at least one alkyl aluminum co-catalyst.

18. The method of claim 14 where the polymerization temperature is from about 0 to about 150°F (about -18 to about 66°C), and the temperature does not vary by more than about 5°F (about 3°C), during the polymerization.

19. The method of claim 14 where the polymerization temperature is from about 0 to about 150°F (about -18 to about 66°C), and the temperature can vary by up to 80°F (about 44°C), during the polymerization.

20. The method of claim 14 where the release agent is selected from the group consisting of silicones, silicone emulsions, polyethylene glycols, polyethylene waxes, polytetrafluoroethylene dispersions, and sleeves made from polyethylene.

21. The method of claim 14 where the release agent is applied to the inner chamber surface with an application plunger.

22. The method of claim 14 where the harvesting plunger has a cross-section that mates with the cross-section of the linear void space.

23. The method of claim 13 further comprising cleaning each reaction chamber with a cleaning plunger.

24. An apparatus for preparing a polymer comprising:

at least one reaction chamber configured as a linear void space with a linear axis and a cross-section and first and second ends, the linear void space surrounded by a chamber wall having an inner chamber surface and an outer heat exchange surface, where the first and second ends may be opened and closed;

a shell surrounding the outer heat exchange surface for passing coolant over the outer heat exchange surface; and

at least one harvesting plunger, where the harvesting plunger has a linear axis co-linear with the linear axis of the at least one reaction chamber, where the harvesting plunger travels within the corresponding void space from the first end to the second end along the axes to remove essentially all of the at least partially cured polymer from the chamber.

25. The apparatus of claim 24 where the cross-section of each reaction chamber is uniform along the linear axis.

26. The apparatus of claim 24 further comprising a plurality of reaction chambers where the linear axes of all chambers are parallel.

27. The apparatus of claim 26 further comprising a plurality of harvesting plungers.

28. The apparatus of claim 24 where a polymerization can be conducted at a temperature from about 0 to about 150°F (about -18 to about 66°C), and the polymerization temperature does not vary by more than about 5°F (about 3°C), during the polymerization.

29. The apparatus of claim 24 where the polymerization temperature is from about 0 to about 150°F (about -18 to about 66°C), and the temperature can vary by up to 80°F (about 44°C), during the polymerization.

30. The apparatus of claim 24 further comprising a first subsystem for purging each reaction chamber with a gas or liquid inert to the polymerization.

31. The apparatus of claim 24 further comprising a second subsystem for applying a release agent to the inner chamber surface of each reaction chamber.

32. The apparatus of claim 31 where the second subsystem comprises at least one application plunger, where the application plunger bears release agent and is designed to apply release agent to substantially the entire the inner chamber surface of a reaction chamber.

33. The apparatus of claim 24 where each harvesting plunger has a cross-section that mates with the uniform cross-section of the linear void space.

34. The apparatus of claim 24 further comprising at least one cleaning plunger.

35. An apparatus for preparing a polymer comprising:

at least one closed reaction chamber configured as a linear void space with a linear axis and a cross-section and first and second ends, the linear void space surrounded by a chamber wall having an inner chamber

surface and an outer heat exchange surface, where the first and second ends may be opened and closed;

a shell surrounding the outer heat exchange surface for passing coolant over the outer heat exchange surface;

at least one harvesting plunger, where the harvesting plunger has a linear axis co-linear with the linear axis of the at least one reaction chamber, where the harvesting plunger travels within the corresponding void space from the first end to the second end along the axes to remove substantially all of the at least partially cured polymer from the chamber;

a first subsystem for purging each reaction chamber with a gas or liquid inert to the polymerization; and

a second subsystem for applying a release agent to the inner chamber surface of each reaction chamber.

36. The apparatus of claim 35 where the cross-section of each closed reaction chamber is uniform along the linear axis.

37. The apparatus of claim 35 further comprising a plurality of reaction chambers where the linear axes of all reaction chambers are parallel.

38. The apparatus of claim 37 further comprising a plurality of harvesting plungers.

39. The apparatus of claim 35 where a polymerization can be conducted at a temperature from about 0 to about 150°F (about -18 to about 66°C), and the polymerization temperature does not vary by more than about 5°F (about 3°C), during the polymerization.

40. The apparatus of claim 35 where the polymerization temperature is from about 0 to about 150°F (about -18 to about 66°C), and the temperature can vary by up to 80°F (about 44°C), during the polymerization.

41. The apparatus of claim 35 where the second subsystem comprises at least one application plunger where the application plunger bears release agent and is designed to apply release agent to substantially the entire the inner chamber surface of a reaction chamber.

42. The apparatus of claim 35 where each harvesting plunger has a cross-section that mates with the cross-section of the linear void space.

43. The apparatus of claim 35 further comprising at least one cleaning plunger.